Transport of MTBE through Vadose Zone
Site 261, Santa Clara Valley Water District Study

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Transport of MTBE through Vadose Zone
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- Site 261- one of sites in SCVWD study to assess MTBE release from UST systems meeting 1998 federal and state mandated upgrade requirements
  - Site 261 had highest MTBE concentrations in groundwater; soil and soil gas
    - BTEX concentrations were negligible in groundwater, soil and soil gas
  - Station still operating but use of MTBE discontinued in January, 2001

- In August, 2002 collected data to supplement to SCVWD study
  - Preliminary Review of Study
    - Methods & Results
  - Discuss results in terms of the USGS R-UNSAT transport model

- Surprising Interpretation (Speculation)

Santa Clara Valley Study - MTBE at sites without known gasoline spills.

List of maximum concentration for samples taken at sites with highest MTBE concentrations in groundwater. Interpretation given in right column.

Site ID	Groundwater MTBE (ug/L)	Soil MTBE (ug/Kg)	Soil Gas MTBE (ug/L)	Comments
261	200,000	15,000	820	no BTEX in soil
505	25,000	2,400	68	no BTEX in soil
342	1,700	140	91	no BTEX in soil
287	800	ND	20	MTBE not well documented in vadose zone
598	280	260	520	no BTEX in soil
592	40	110	580	no BTEX in soil
332	26,000	1,800	not sampled	no BTEX in soil
73	6,700	11	0.011	MTBE not well documented in vadose zone
405	ND	ND	8.1	MTBE not well documented in vadose zone

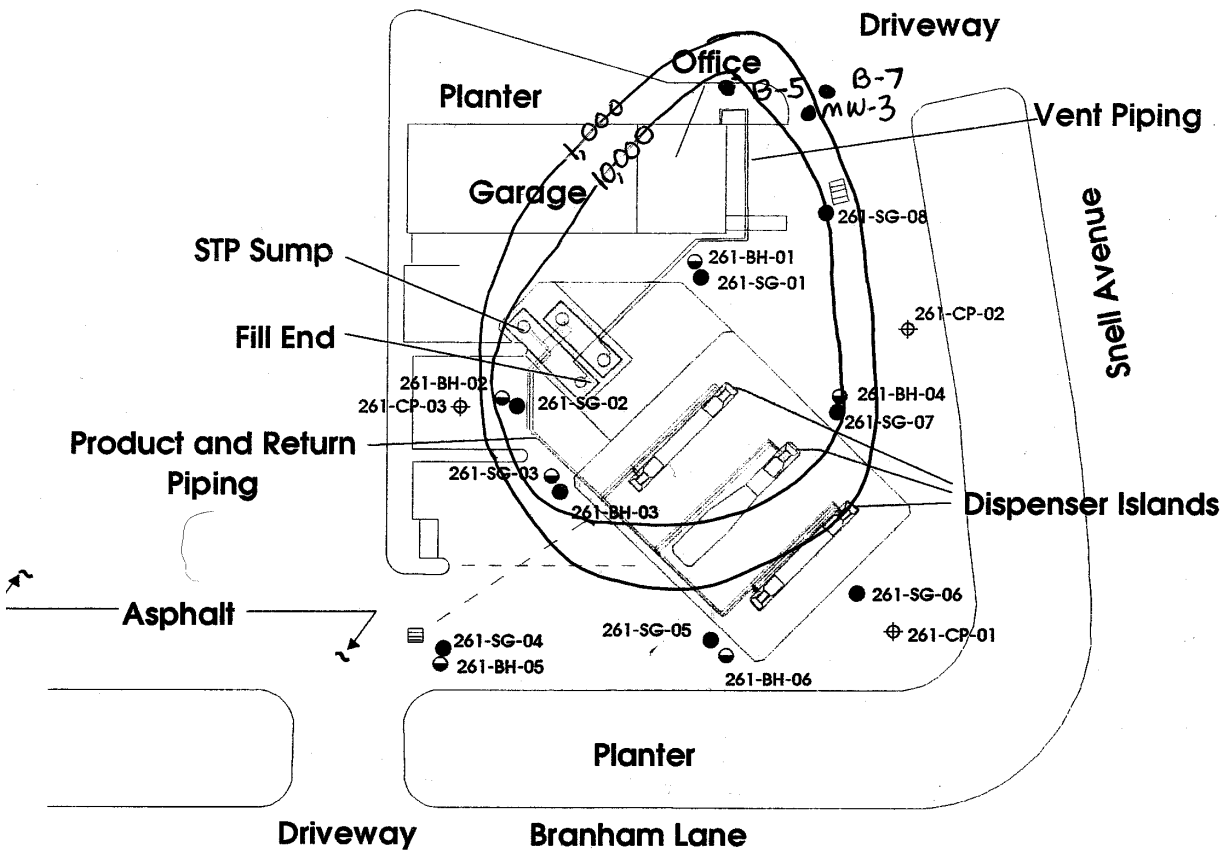

rake Service
Wheel Alignment
Smog Check
QUALITY GASOLINE
PRODUCED WITHOUT MTBE

Santa Clara Valley Water District Study

- Santa Clara Valley Water District Study - Soil Gas Results
  - Highest soil gas concentrations for MTBE were for samples collected below top of groundwater
    - Presume soil gas sample collected at sub-ambient pressure and MTBE was stripped from pore water
    - New soil gas samples to be collected at near-ambient pressure

- Santa Clara Valley Water District Study - Soil Results
  - Area near tank/piping - high MTBE in soil throughout vadose zone
    - New soil samples at 2 foot interval
    - Measurement of soil moisture and porosity
    - Convert soil measurements to MTBE concentrations in pore water

- Transport Model [clay-rich soil - vadose zone transport in percolation water]
  - Site evaluation to better understand ‘recharge rate’ for percolation water



Legend

- Gasoline underground storage tank, product and return piping, and dispenser
- UST access port
- Concrete slab
- Storm Drain Catch Basin
- Underground utilities
- Soil and groundwater sampling location
- Soil-gas sampling location

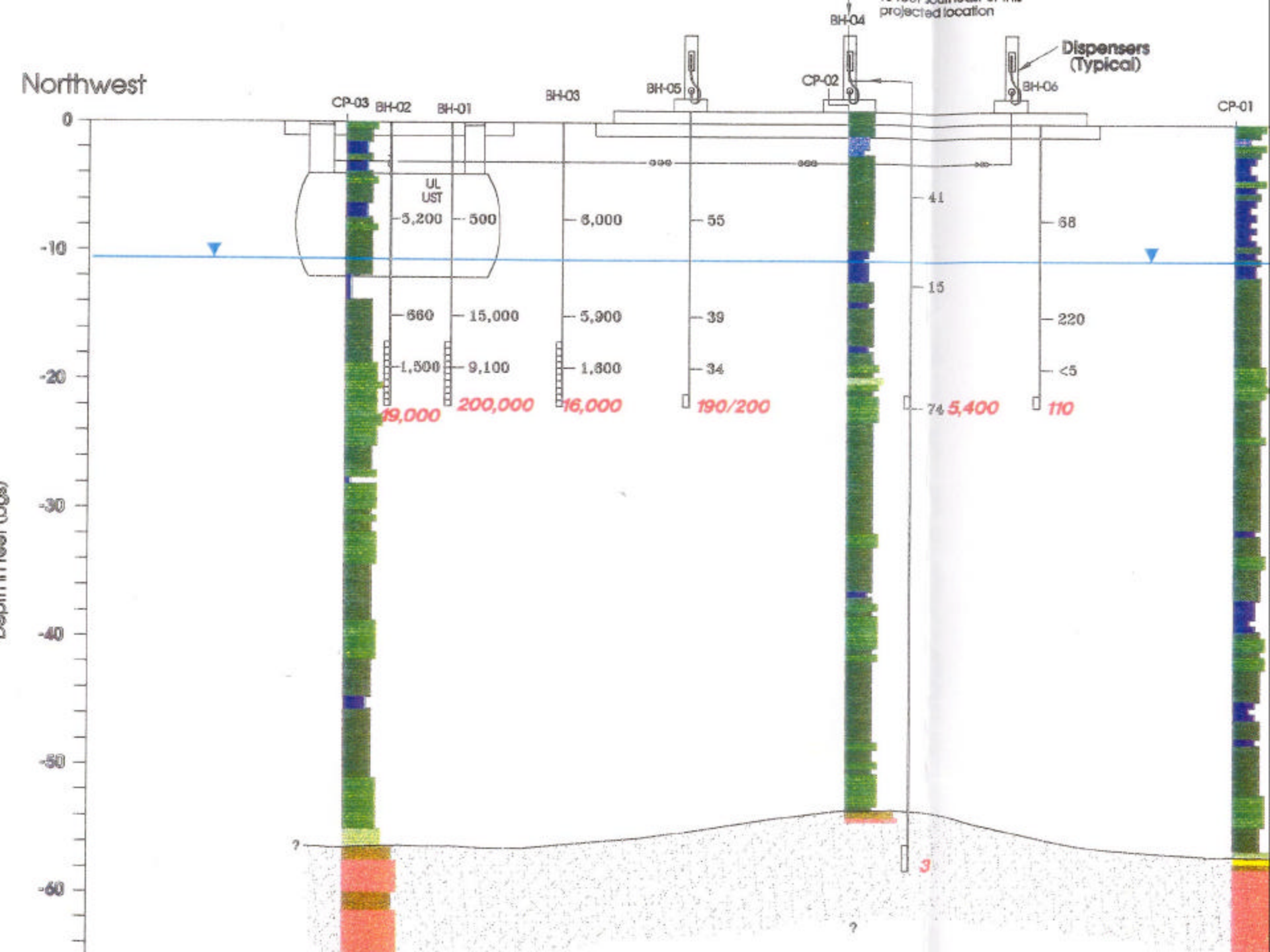
MTBE (ppb) — June, 2001

N

50 0 50 Feet

Soil gas collected with syringe so that gas flow from soil could be controlled. Soil gas samples were collected only at depths less than 13 feet (top of groundwater). Sample quality was not considered good due to low permeability of soil.

Soil was collected as continuous cores. After visual review, adjacent samples were capped for EPA 8260 analysis and soil physical property determination. Water content data indicated that most samples were essentially saturated with water.


projected location
BH-04
Dispensers
(Typical)
Northwest
CP-03
BH-02
BH-01
BH-03
BH-05
CP-02
BH-06
CP-01
UL
UST
5,200
500
6,000
55
41
68
660
15,000
5,900
39
15
220
1,500
9,100
1,800
34
<5
49,000
200,000
16,000
190/200
74
5,400
110
3
0
-10
-20
-30
-40
-50
-60
?
?

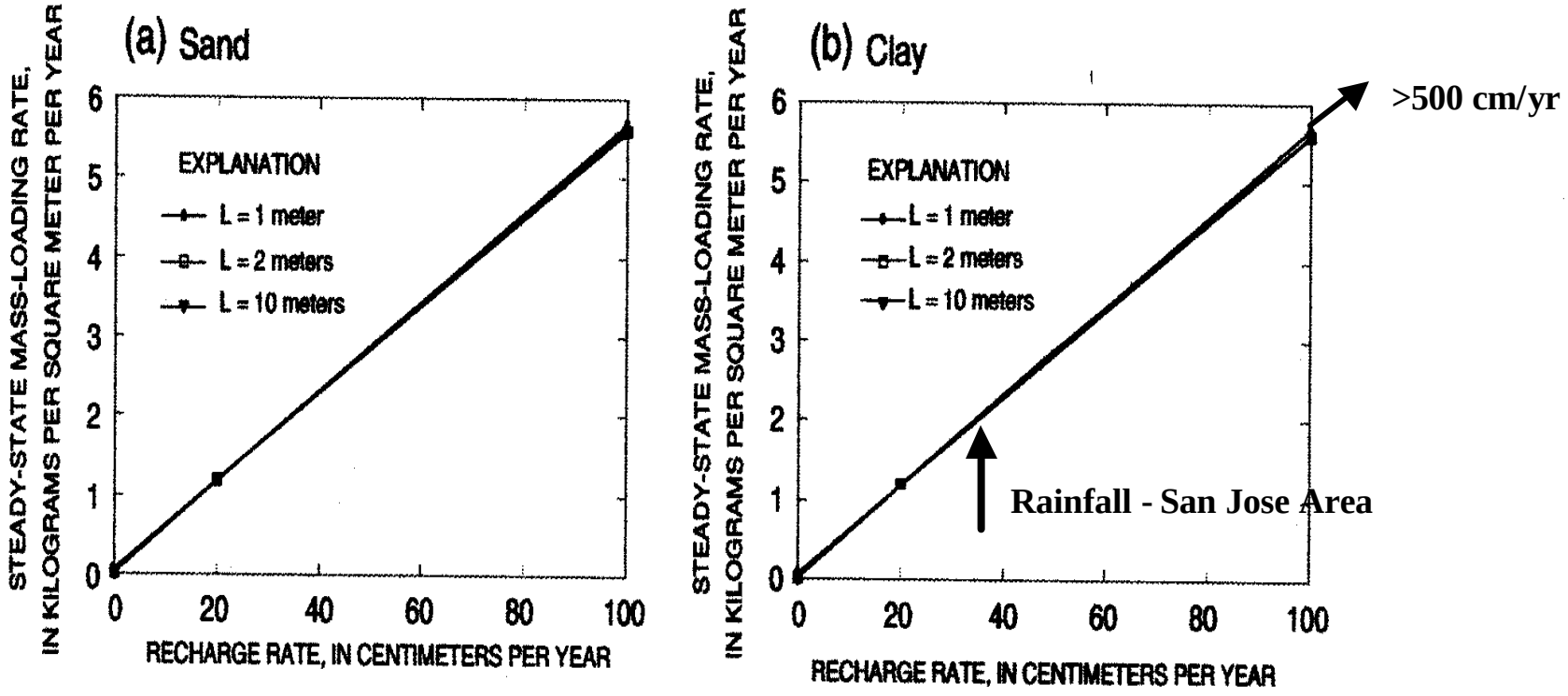


Figure 2. Steady-state mass-loading rate of MTBE to ground water as a function of recharge rate (q) and depth to ground water (L) for a chronic small-volume release of gasoline in (a) sand and (b) clay. (The relation of mass-loading rate to recharge rate is illustrated at recharge rates exceeding 20 centimeters per year for clay (Figure 2b) for comparative purposes only. Recharge rates as high as or exceeding 20 centimeters per year in clay are unlikely.) Plots for sand and clay are similar because the diffusion properties through the capillary fringe are similar in each soil type.

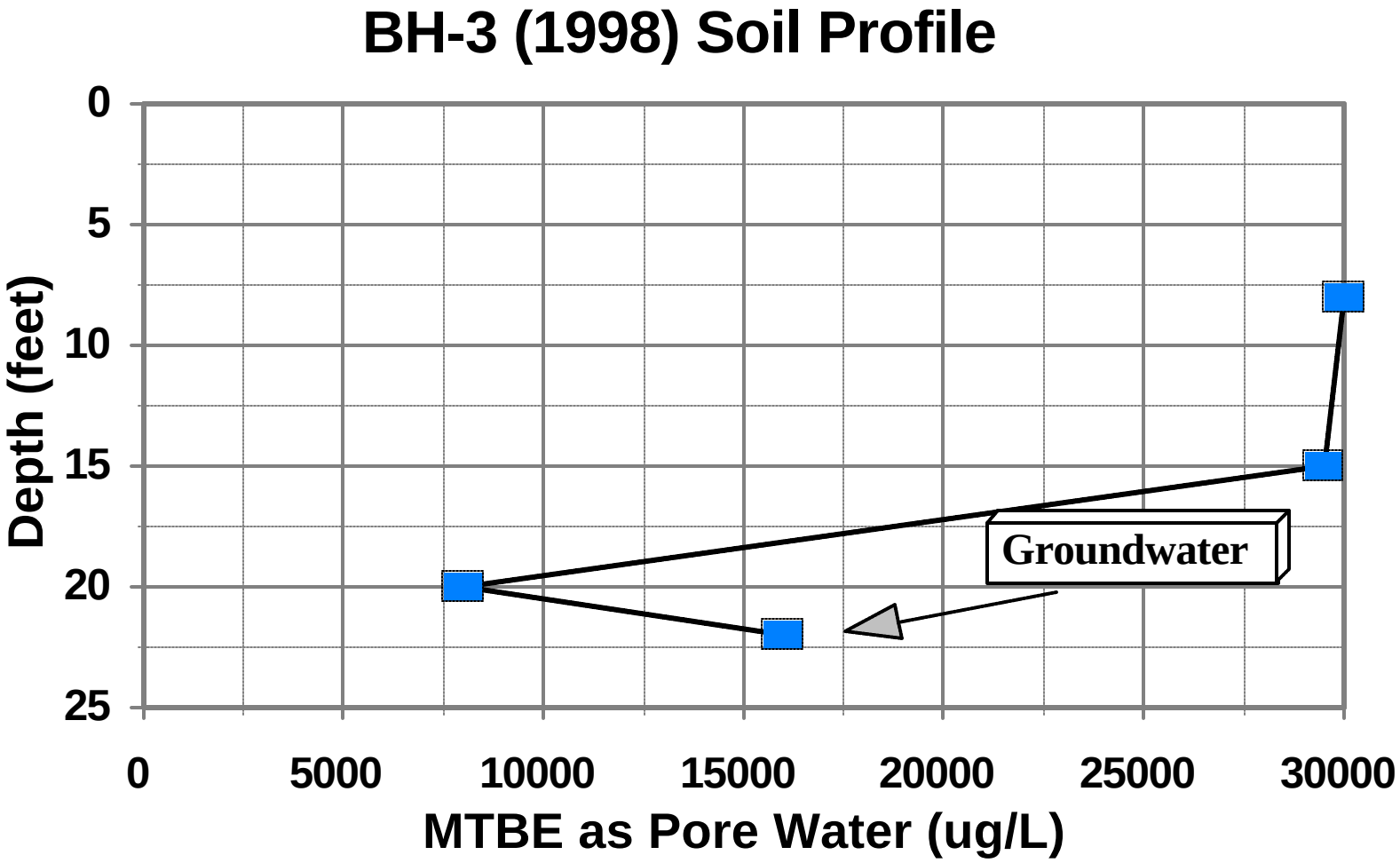
PHYSICAL PROPERTIES DATA

(METHODOLOGY: ASTM D2216, ASTM D422/4464M, API RP40, WALKLEY-BLACK)

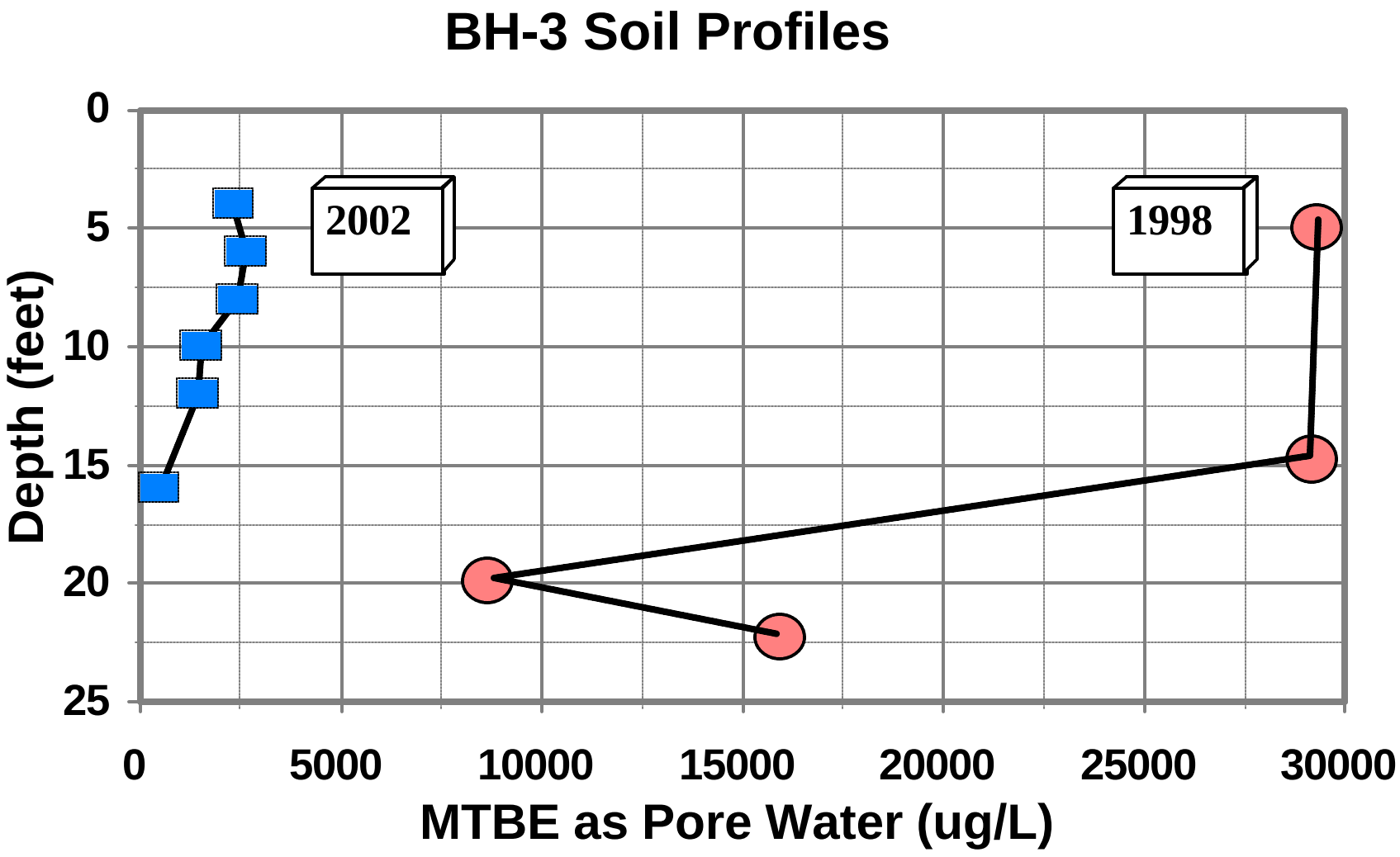
PROJECT NAME: 151 Branham Ave., San Jose, CA
PROJECT NO: N/A

SAMPLE ID.	DEPTH, ft.	SAMPLE ORIENT. (1)	GRAIN SIZE DESCRIPTION, percent			MOISTURE CONTENT (% wt)	DENSITY		POROSITY, %Vb (2)		PORE FLUID SATURATIONS, % Pv (3	
			SAND	SILT	CLAY		BULK (g/cc)	GRAIN (g/cc)	EFFECTIVE	AIR FILLED	WATER	NAPL
BH1A	6.5-7.0	V	13.4	68.7	17.9	17.4	1.70	2.71	37.1	7.3	80.2	ND<0.01
BH1A	15.0-15.5	V	5.7	71.0	23.3	24.8	1.54	2.69	43.0	5.2	87.9	ND<0.01
BH3A	6.5-7.0	V	9.5	72.2	18.3	20.1	1.65	2.70	38.8	5.6	85.6	ND<0.01
BH3A	8.5-9.0	V	4.3	74.8	20.9	19.7	1.75	2.69	34.9	0.4	98.8	ND<0.01
BH3A	10.5-11.0	V	6.7	74.2	19.1	20.2	1.68	2.69	37.6	3.8	89.9	ND<0.01
BH3A	12.5-13.0	V	5.3	73.0	21.6	24.3	1.57	2.69	41.7	3.4	91.7	ND<0.01
BH3A	15.0-15.5	V	9.2	70.1	20.7	24.4	1.60	2.69	40.6	2.7	93.4	ND<0.01
BH4A	4.5-5.0	V	5.2	75.3	19.5	16.5	1.85	2.69	31.2	0.1	99.6	ND<0.01
BH4A	6.5-7.0	V	7.4	72.7	19.9	16.4	1.74	2.70	35.7	7.0	80.3	ND<0.01
BH4A	15.5-16.0	V	7.7	70.5	21.8	25.1	1.57	2.69	41.8	3.3	92.1	ND<0.01

Site 261


BH-3 (1998) Soil Profile
Depth (feet)
0
5
10
15
20
25
0
5000
10000
15000
20000
25000
30000
MTBE as Pore Water (ug/L)
Groundwater

Site 261


BH-3 Soil Profiles
Depth (feet)
0
5
10
15
20
25
2002
1998
0
5000
10000
15000
20000
25000
30000
MTBE as Pore Water (ug/L)

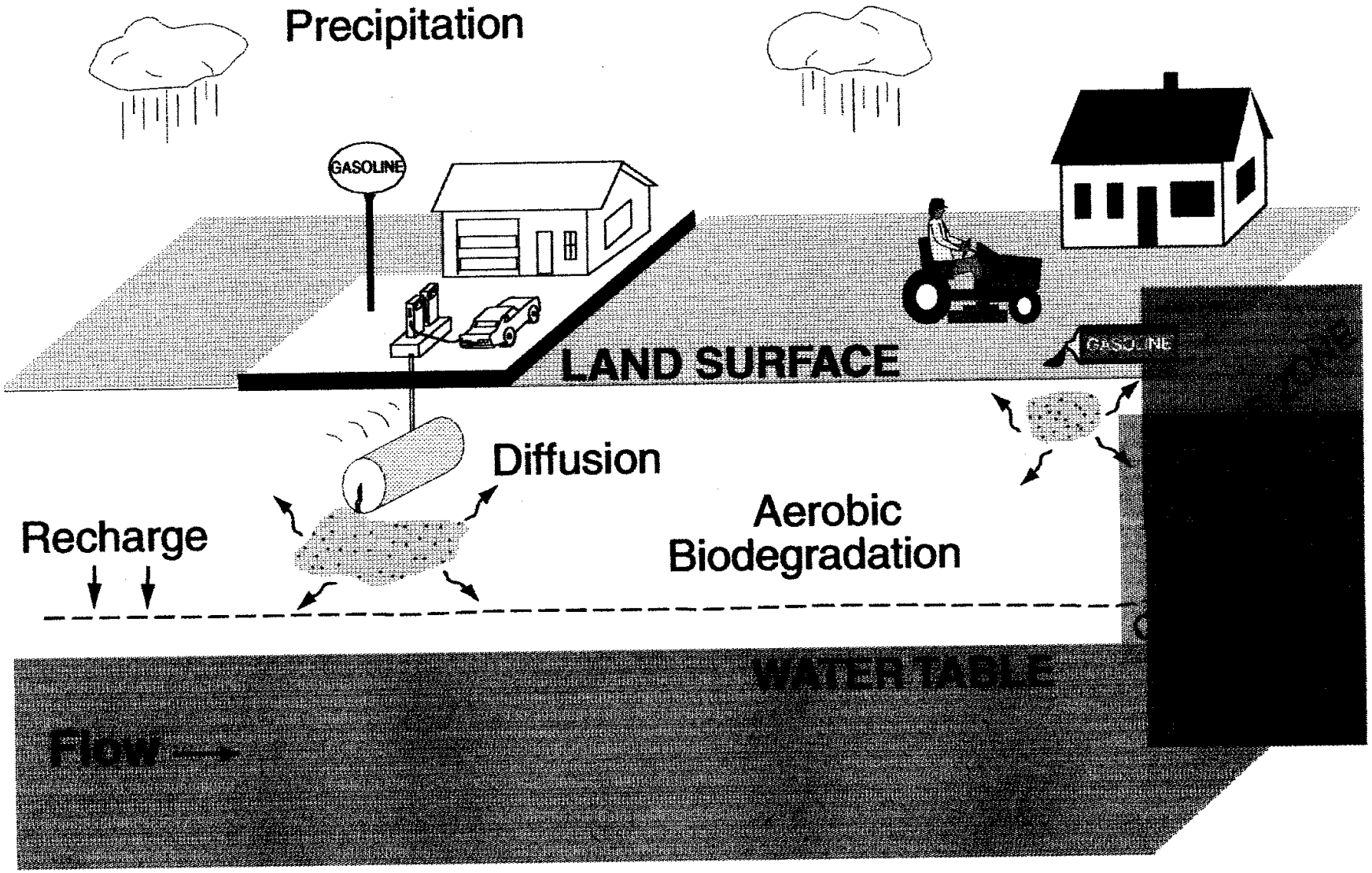
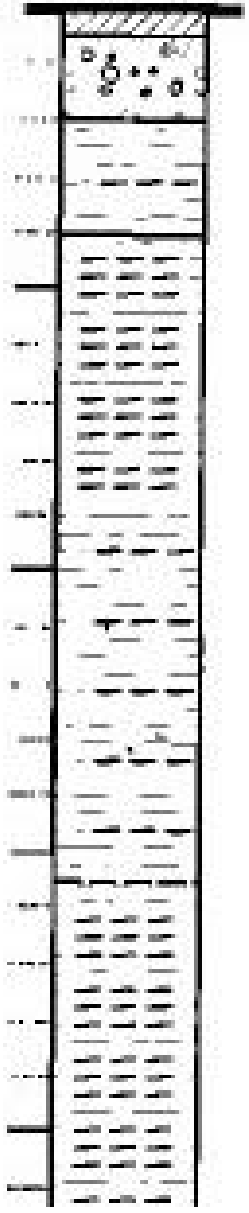
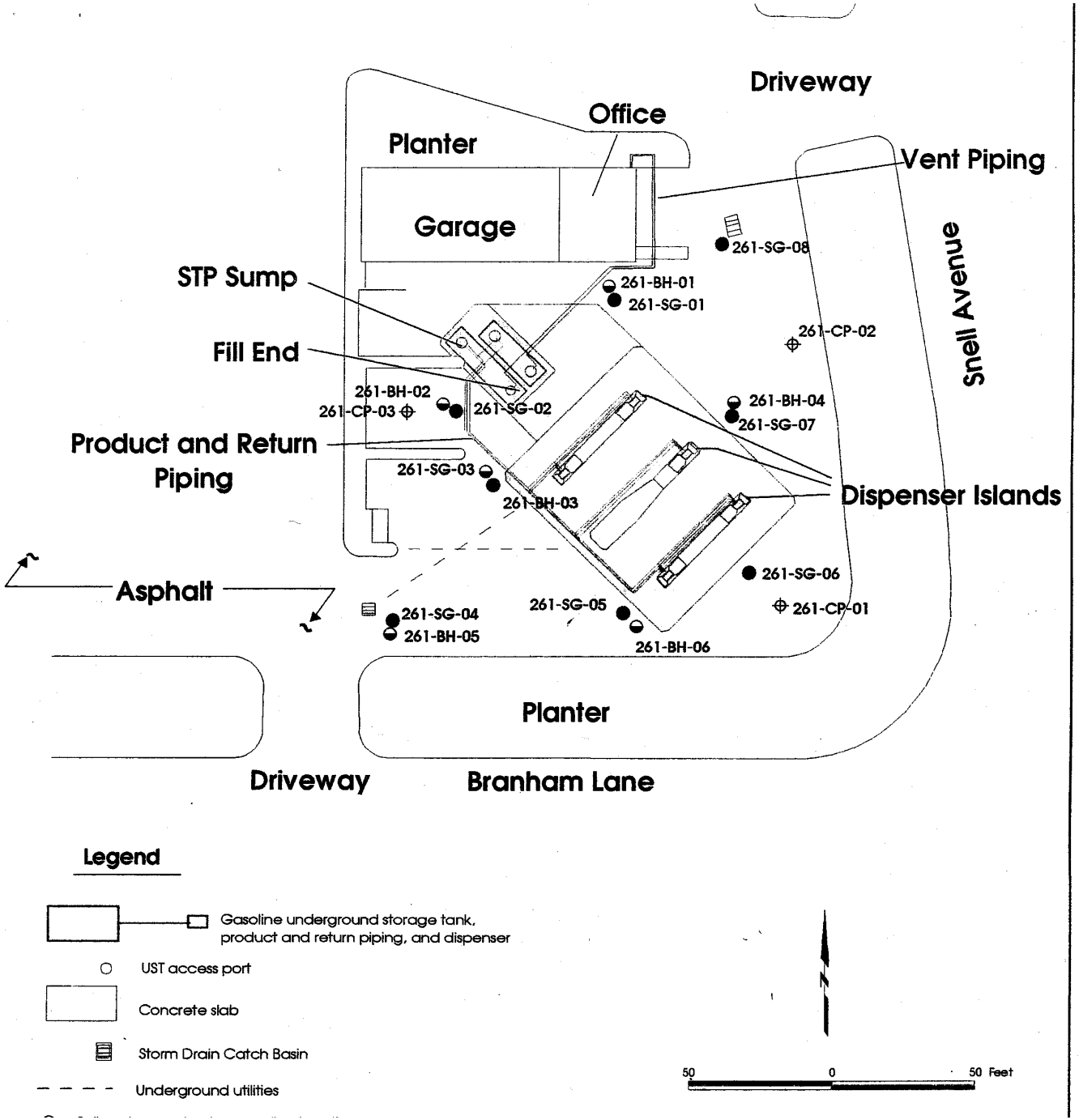


Figure 1. Conceptual diagram of contaminant transport in the vadose zone at small-volume gasoline-release sites where the released product is immobilized above the water table.

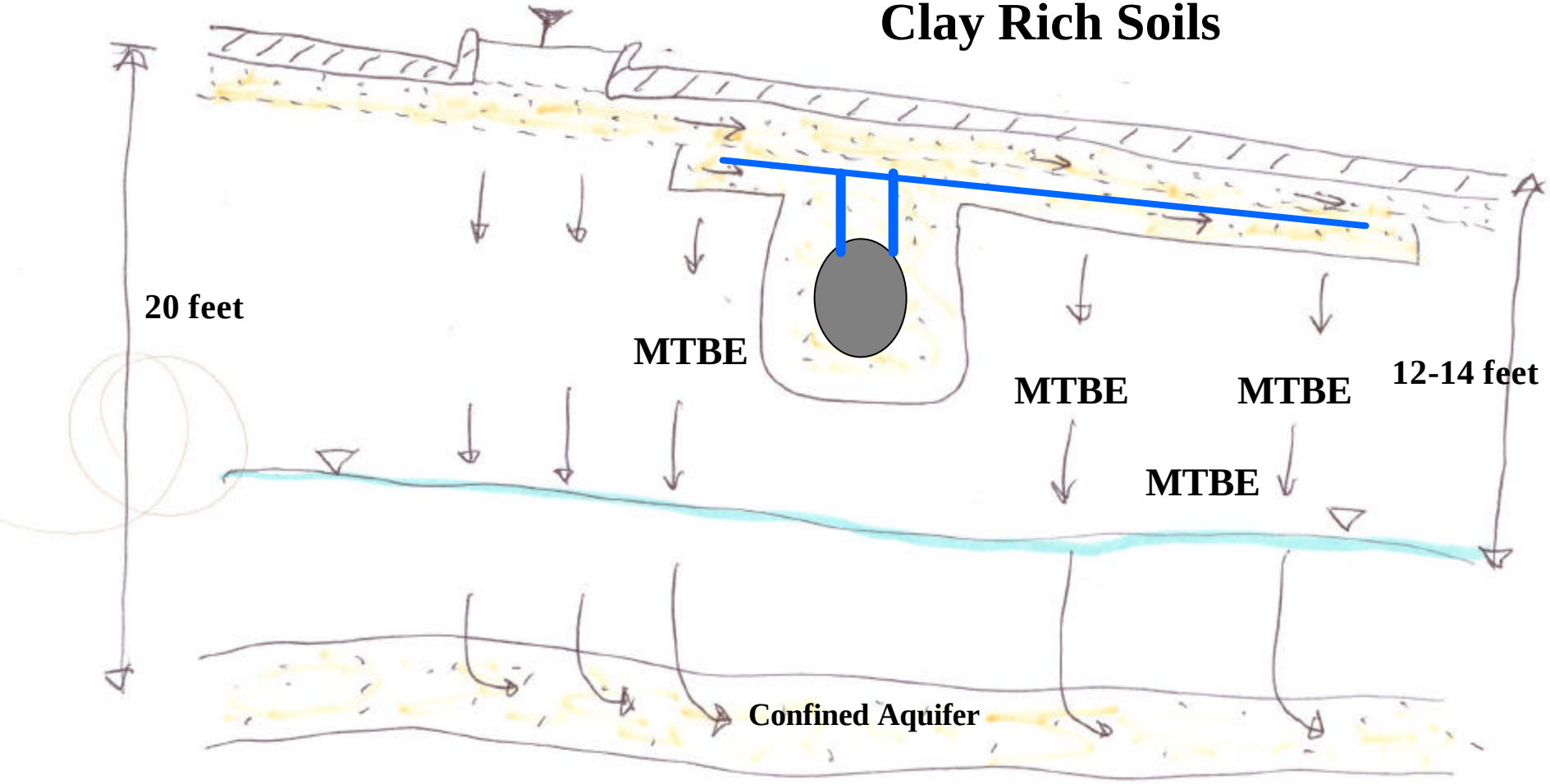

.00¢
.00¢
.00¢

SCVWD PILOT STUDY

Depth, feet	Water Level	PID Reading (ppm)	Graphic Log	Lithologic Description
				ASPHALT Pavement. GRAVEL, engineered fill.
		2.2		SILTY CLAY (CL), very dark gray, slightly moist, gravelly.
		180.0		
5				CLAYEY SILT - SILTY CLAY (ML-CL), dark brown, slightly moist, moderate plasticity, medium dense, slightly sandy, fine sand.
		19.8		
				Increasingly more clayey.
10		2.6		Color more dark grayish brown.
		3.8		
15				CLAYEY SILT (ML), dark yellowish brown, slightly moist to moist, moderate plasticity, soft, slightly sandy (fine sand).
		0.0		
20				Increasing sand (fine sand).


Driveway
Office
Planter
Vent Piping
Garage
261-SG-08
Snell Avenue
STP Sump
261-BH-01
261-SG-01
261-CP-02
Fill End
261-BH-02
261-CP-03
261-SG-02
261-BH-04
261-SG-07
Product and Return Piping
261-SG-03
261-BH-03
Dispenser Islands
Asphalt
261-SG-06
261-SG-05
261-CP-01
261-SG-04
261-BH-05
261-BH-06
Planter
Driveway
Branham Lane
Legend
Gasoline underground storage tank, product and return piping, and dispenser
UST access port
Concrete slab
Storm Drain Catch Basin
Underground utilities
50
0
50 Feet

Conceptual Model - Site 261
Clay Rich Soils



Planter Area 10% or less
Local Rainfall = 14.6 inches/year
Sprinkler = 2 inches/hour
Sprinklers @ 20 minutes/day surpasses SHC of clay
High rate of recharge to aquifer minimizes dilution

Site 261: 20 feet to groundwater
SHC = 0.06 cm/hr (clay)
Transport time = 1.15 years
Stop MTBE - 1/01
Stop loading MTBE to aquifer - 3/02

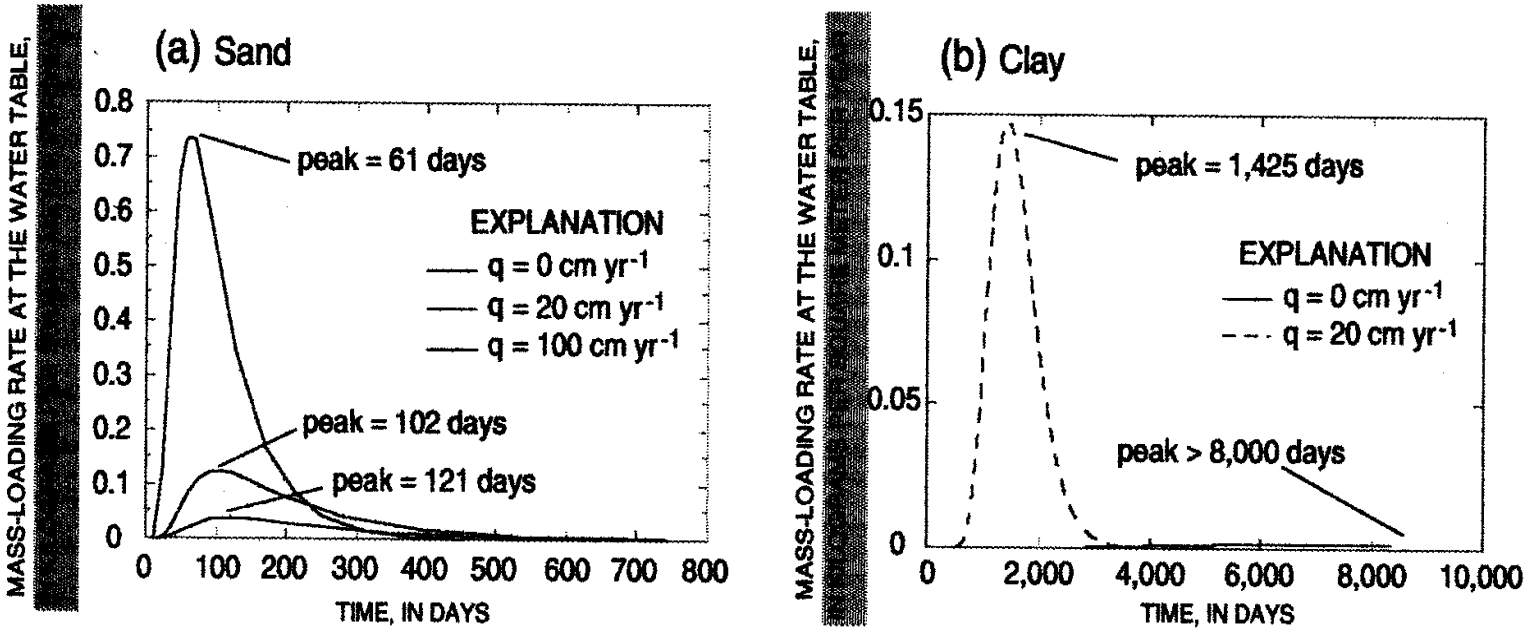


Figure 4. Mass-loading rate of MTBE at the water table as a function of time and recharge rate (q) for a 1 gallon release of gasoline in (a) sand and (b) clay at a distance 2 meters above the water table.

Conclusions

- **MTBE vapor source in clayey soils**
  - **Site specific ‘recharge’ water flow important**
  - **Use drip system instead of sprinklers in certain planters?**
  - **Expect relatively quick response after quit using MTBE**
  - **Soil gas collection limited value**
- **MTBE transport models for vadose zone (flushing vs extraction)**
  - **Make sure use correct conceptual model**
  - **Collect data specific for model - supplement site assessment data**